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SECTION 02554 - WASTEWATER COLLECTION SYSTEM

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SECTION 02554

WASTEWATER COLLECTION SYSTEM

PART 1 - PRODUCTS

Material and equipment used in the work shall conform to one of the following:

1.01 SEWER PIPE

- A. PVC Pipe for Gravity Sewer - Shall be SDR 26 polyvinyl chloride plastic and shall meet all requirements of the ASTM D-3034 for diameters 4" through 15", latest revision or ASTM F679 for diameters 18" through 48", latest revision. PVC pipe shall be installed in accordance with ASTM D-2321, latest revision. All pipes shall be suitable for use as a gravity sewer conduit and shall be green in color. Provisions must be made for contraction and expansion at each joint with a rubber ring. Standard laying lengths shall be thirteen (13) feet or fourteen (14) feet, ± 1 -inch, for all sizes. Fittings shall meet the same specification requirements as the pipe.

Tests on PVC Pipe - Shall be designed to pass all tests at 73° F. ($\pm 3^{\circ}$ F.)

- B. PVC Pipe for Force Main

PVC Pipe - Plastic pipe shall be PVC SDR 18, C-900 for 12-inch and smaller and SDR 18, C-905 for 14-inch and larger. All pipe shall conform to ASTM D-2241 and be installed in accordance with ASTM D-2321.

Pipe shall bear the National Sanitation Foundation seal of approval and shall comply with the requirements of Type I, Grade I (PVC 1120) of the ASTM resin specification D-1784. Certificates of conformance with the foregoing specifications shall be furnished with each lot of pipe supplied.

PVC pipe for force mains shall be green in color, and shall be furnished in nominal 18 to 20 foot laying lengths unless otherwise noted.

- C. Ductile Iron Pipe - Shall conform to AWWA C-150, AWWA C-151 and ASTM A-746 latest revisions. All pipes shall be thickness Class 50 unless otherwise noted.

Coatings and Linings: All ductile iron pipes and fittings shall be bituminous on the outside and lined with 40-mils of Protecto 401 Ceramic Epoxy in the inside.

1. Coating on the outside shall be a bituminous coating approximately 1 mil thick. The finished coating shall be continuous, smooth, neither brittle when cold or sticky when exposed to the sun, and shall be strongly adherent to the iron.
2. Protecto 401 Ceramic Epoxy interior lining shall conform to Permeability rating ASTM E-96-80, Salt Spray ASTM B-117-09, Cathodic Disbondment ASTM G6-95, and Immersion Testing ASTM D-714-02.

The interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401 ceramic epoxy. Interior lining shall not be applied below 40° F.

Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto 401 Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends.

Lining application, inspection, certification, handling and surface preparation of the area to receive the protective coating shall be in accordance with the Protecto 401 manufacturer specification and requirements. Lining shall not be used on the face of the flange.

1.02 SEWER PIPE JOINTS

A. Gravity Sewer Pipe

1. Joints for PVC Pipe - Shall be integral wall bell and spigot with a rubber ring gasket. The joints shall conform to ASTM D-3212 latest revision and the gaskets shall conform to ASTM F-477 latest revision.
2. Joints for Ductile Iron Pipe - Shall comply with the requirements of 1.02 B.2.

B. Force Main Pipe

Joints shall be in accordance with ASTM D-3036. All PVC fitting must have NSF-61 approval and must comply with, or exceed AWWA C907. Saddle type fittings shall not be used.

1. Plastic pipe shall be jointed by means of a rubber ring bell joint which shall be an integral part of the barrel or solvent welded at the factory. The joints shall have a space to provide expansion and contraction of the pipe without leaking. Fittings for plastic pipes shall be PVC with ring tightened rubber joints; or ductile iron with adapters to PVC pipe. Pipe shall be manufactured to ductile iron pipe equivalent outside diameter.

The bell shall consist of an integral wall section with a bonded-in solid cross section elastomeric ring which meets the requirements of ASTM F-477 and ASTM D-3139. The bell section shall be designed to be at least as hydrostatically strong as the pipe wall and meet the requirements of C900-07 or C905-10.

Each standard and random length of pipe shall be tested to two times the rated pressure of the pipe for a minimum of five (5) seconds. The integral bell shall be tested with the pipe.

2. Ductile Iron Joints – For various applications should meet the below criteria:
 - a. Flanged Joints: Shall conform to ANSI Specification 21.2(AWWAC–150). Flanges shall be Class 125. Gaskets for flanged pipe and fittings shall be 1/16-inch ring gasket of red sheet rubber. Bolts and bolt studs shall conform to ANSI Specification B 16.1 (AWWA C-153).
 - b. Mechanical Joints: In cast and ductile iron pipe shall conform to ANSI Specification A 21.11 (AWWAC-111). All glands shall be made of ductile iron only.
 - c. Push-On Joints: Shall have a rubber gasket that fits into a retainer recess in the bell and produces a watertight joint when the spigot is pushed home.
 - d. Restrained Joints - Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to "Mega-Lug" or push-on type joints equivalent to "Lock-Ring," "TR Flex", or "Super Lock" and shall have a minimum rated working pressure of 250 psi. Mechanical joint retainer glands shall comply with the manufacturer's specifications for the pipe material (ductile iron vs. PVC). The joints shall be in accordance with the applicable portions of ANSI/AWWA C111/A21.11. The manufacturer of the joints shall furnish certification, witnessed by an independent laboratory, that the joints furnished have been tested at a pressure of 500 psi without signs of

leakage or failure. All wedge assemblies and related parts of restraint devices shall be processed through an iron-phosphate spray, rinse and drying operation in preparation for coating application. The coating shall consist of a minimum of two coats of liquid Xylan® fluoropolymer coating with heat cure to follow each coat. All casting bodies of restrained joints shall be surface pre-treated with an iron-phosphate spray, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. The coating shall be a polyester based powder to provide corrosion, impact and UV resistance. The coating system shall be Mega-Bond™ by EBAA Iron, or approved equal. Restrained joints shall be capable of being deflected after assembly. Restrained joints shall have a preset deflection of no more than 5° and shall be able to take up 3° of deflection after burial.

- e. Couplings - All connections of new sewer pipe to existing sewer pipe shall use rigid couplings. Flexible (e.g. Fernco) couplings shall not be allowed. Couplings shall be PVC double bell type, ductile iron mechanical joint solid sleeve type or ductile iron straight and transition type (e.g., Dresser Couplings) depending on the application.

C. Ductile Iron Fittings

Fittings shall consist of bends, tees, crosses, caps and plugs, reducers, tapped tees, sleeves, etc. All fittings furnished shall be cast and machined at one foundry location to assure quality control and provide satisfactory test data. Fittings shall have cast on them the pressure rating, nominal diameter of openings, manufacturer's name, foundry location, plant code, and degrees of fraction of the circle. Cast letters and figures shall be on the outside body of the fitting. Ductile iron welded on outlets is not acceptable.

1. Fittings for Push-On and Mechanical Joint Pipe shall be ductile iron, manufactured in accordance with ANSI A21.10 (AWWA C-110) or ANSI A21.53 (AWWA C-153) standards. Fittings shall be designed to accommodate the type of pipe used.
2. Fittings for Flanged Pipe: Shall be manufactured in accordance with ANSI B16.1, Class 125 flanges. Bolt circles and bolt holes shall also meet ANSI B16.1.

1.03 AIR RELEASE VALVES

A. General

Air Release Valves (ARV's) shall be provided as required by the Engineer, who shall specify ARV type (or function), size, and location. The ARV's specified below are combination air and vacuum release valves in two-inch and four-inch sizes, suitable for most forcemain applications.

The specification of these two (2) valves below does not relieve the Engineer of the responsibility to select and locate ARV's for proper forcemain operation and long-term durability. ARV selection shall be in accordance with AWWA Manual of Water Supply Practices M51 - Air-Release, Air/Vacuum & Combination Air Valves, the manufacturer's published information, and the Engineer's experience.

The manhole and installation of the two-inch valve shall be in accordance with the City of Savannah Standard Construction Detail S-11. Prior to deciding on the location of any air release valve, the Contractor shall provide the Engineer with an accurate profile of the installed force main so that high points in the system can be determined. The locations of the air release valves shall be field adjusted based on the locations of the high points.

B. Small (2") Air Release Valves for Sanitary Mains

Two-inch air release valve shall be a combination air valve of heavy-duty "Universal" style with a single body unit incorporating the functions of an air and vacuum valve with an air release valve in a single housing. ARV shall release accumulations of air at high points of a force main by exhausting large volumes of air as the main is being filled, and release accumulated pockets of air while the main is in operation and under pressure. ARV shall also be designed to permit large volumes of air to enter the main during drainage.

The valve body and cover flange shall be cast or fabricated 316 stainless steel and shall incorporate a "sanitary clamp" to attach the flange to the body at the outlet. The inlet shall be 2" NTP standard and the outlet 1" NPT standard. The flange clamp must be located at the outlet of the body for ease of cleaning and maintenance. 1/2" taps and plugs shall be provided in the upper and lower bosses. Piping, nipples, and plugs shall be Schedule 40, type 316 stainless steel.

All non-sealing internal metal components shall be 316 stainless steel. No plastic, nylon, or fiberglass components will be acceptable. The valve shall incorporate an air release orifice of 3/16" for use at 200 psig. This orifice will be located in the outlet of the valve and shall be drilled in a 316 stainless steel orifice plate that seals against a Buna-N rubber seat. Valve shall be suitable for working pressures of 2-40 psi.

Unit may have a maximum height of 14 inches and a maximum weight of 28 lbs. The valve shall be Crispin "X" Series, model # UX20-L or approved equal.

C. Large (4") Air Release Valves for Sanitary Mains

Four-inch ARV's shall be infinitely variable automatic air and vacuum valves designed to allow escape of air for an operating range starting from pressure range: 0.0 through 250 psi (0 – 17.2 bar), close watertight when liquid enters the valve even when the fluid is rising without pressure (no minimum operating pressure required), allow air to enter in the event of a vacuum, and soft working behavior as water hammer inhibition realized by roll-on diaphragm and spring mechanism. When the sealing device of the valve is closed an air cushion is trapped between the fluid and sealing area, a mud deflector made of PE allows no contact between fluid and sealing area. The valve body and spindle spring shall be stainless steel, grade 316Ti, designed to facilitate disassembly for cleaning and maintenance. The float shall be Delrin (POM); the valve seat and all working parts shall be of corrosion-resistant materials. Valves shall be equipped with the necessary attachments, including ball valve and camlock fitting to permit back flushing after installation without dismantling the valve. Valves shall be recommended by the manufacturer for wastewater service.

Automatic air and vacuum release valves shall be combination style, stainless steel Model # 986 as manufactured by Hawle and as distributed by H-Tec USA.

1.04 MANHOLES

- A. Precast Concrete – The minimum wall thickness for precast manholes shall be five (5) inches for 4-foot ID manholes and seven (7) inches for 6-foot ID manholes. Cone sections shall have a minimum wall thickness of eight (8) inches at their top. Manholes shall be manufactured with 4,000 P.S.I. concrete, type II cement that meet ASTM C-150 and absorption shall not exceed 6%. Wall reinforcement shall meet ASTM C-478 and also have a No. 4 rebar hoop around each pipe opening. The flat top slab sections shall handle HS-20 traffic loadings. Bottom slabs shall be six (6) inches thick and be reinforced with No. 4 rebar at nine (9) inch O.C.E.W. All items shall be wet cast. Dry

casting or low slump concrete will not be allowed. All bases will have proper lifting hooks in the bottom slabs (min. of 3) and there shall be no penetrating lifting holes on any structures. No holes will be allowed within six (6) inches of any joint on structures. All manholes shall be coated as per Section 02555.

It shall be the responsibility of the Contractor to insure that the manhole(s) are designed properly for the loading conditions as indicated on the plans. Should the loading conditions require greater structural integrity than the minimum, as herein specified, it shall be the responsibility of the Contractor to utilize a structural design of greater strength.

Manhole sections shall be free from large honeycomb, cracks, spalls, large chips, exposed reinforcing, and broken bells and spigots. Edges of bells and spigots shall be even and straight. Mastic shall be RAM-NEK or equivalent, with primer. The primer shall be applied to all contact surfaces of the manhole joint at the factory in accordance with the manufacturer's instructions.

- B. Ring and Cover - Manhole ring and cover shall be gray cast iron per ASTM A48, Class 35B without perforations and suitable for addition of cast iron or steel rings for upward adjustment of top. The words "CITY OF SAVANNAH SANITARY GEORGIA" shall be cast into the face of the cover in 1.5-inch to 2-inch letters raised flush with the top of the cover. Ring and cover shall have machine ground seats and be an approved equal to model V1327-1 RG V1327GS EPIC SAVANNAH SN as manufactured by E.J. All manhole rings and covers shall be made water resistant by means of dovetail grooves and gaskets in the cover. Provide circular cover with two (2) pick slots for removing cover spaced at 180° and weighing not less than 138 pounds. No stacking lugs shall be allowed.

Proof Load Testing: Traffic service castings shall have a first article proof load test conducted and the results of that proof load test shall be made available to the City upon request. The proof load test shall be conducted in accordance with the methods and procedures outlined in AASHTO M306-10, Section 6, Proof Load Testing. The casting shall be tested on a suitable and calibrated load testing machine and the casting shall hold a 40,000 pound proof load for one minute without experiencing any cracks or detrimental permanent deformation.

- C. Pipe Connections - Pipe/manhole connector shall be one piece rubber boot secured to pipe with stainless steel clamp band and to the manhole with stainless steel expansion ring. Acceptable pipe connector would be Kor-N-Seal Boot, A-lock or equal. Space between pipe connector and pipe OD shall be filled with non-shrink grout.

- D. Manhole Steps – Manhole steps shall be provided at 16-inches O.C. for manholes greater than four (4) feet deep. Steps shall have impact resistant co-polymer polypropylene plastic molded around ½” diameter, grade 60 reinforcing steel. Manhole steps shall be M.A. Industries PS1-PF reinforced plastic step complying with the requirements of ASTM C 478, or approved equal.

1.05 CASING AND CASING SPACERS

- A. Casing pipe shall be steel conforming to ASTM A-139 latest revision, minimum yield strength point of 35,000 psi, and of the diameter and thickness shown on the contract drawings at each crossing. The pipe ends shall be tapered where welding is required. Full pipe lengths shall be provided. No pipe casing lengths less than eight (8) feet shall be allowed unless approved by the Owner. All casing welds shall be continuous and made by a certified welder.

For casing pipe crossings under roadways/railroads, the Contractor shall comply with the regulations of said authority in regard to design, specifications, and construction. State highway casing installations shall be as specified in the GDOT, “Utility Accommodation Manual,” and for railroads, the American Railway Engineering and Maintenance-of-Way Association (AREMA) manual for Railway Engineering, Chapter 1, Part 5, Section 5.3, “Specifications for Pipelines Conveying Non-Flammable Substances,” shall be applicable.

All carrier pipes shall be restrained joint ductile iron or fusible PVC.

Where allowed by the affected utility owner(s), fusible PVC casing may be used with fusible PVC carrier pipe. The design engineer shall calculate the appropriate piping dimension ratio (DR) for fusible PVC casing considering earth, live, and groundwater, service loads and pullback forces.

- B. Casing Spacers shall be bolt on style with a shell made in two (2) sections of Heavy T-304 Stainless Steel. Connecting flanges shall be ribbed for extra strength. The shell shall be lined with a PVC liner. All nuts and bolts shall be 18-8 Stainless Steel. Runners shall be made of Ultra High Molecular Weight Polymer with inherently high abrasion resistance and a low coefficient of friction. Runners shall be supported by risers made of Heavy T-304 Stainless Steel. The combined height of the supports and runners shall keep the carrier pipe a minimum of 3/4-inch from the casing pipe at all times. Installation and spacing of casing spacers shall be as required by the manufacturer. Casing Spacers shall be as manufactured by Cascade Waterworks Manufacturing Company, or approved

equal.

Casing spacers for fusible PVC carrier pipe should be of a projection type that has a minimum number of projections around the circumference that total the number of diameter inches. For example: 8" pipe should have a minimum of 8 projections and 18" pipe should have a minimum of 18 projections. Spacing between spacer rings (span) should be calculated based on the actual installed load (weight of pipe filled with liquid) but should not exceed 10 feet. Refer to the manufacturer's tables for the load carrying capacity of each type of spacer used. Casing spacers should be projection type – non metallic spacers constructed of preformed sections of high-density polyethylene. Spacers should be ISO 9001:2000 certified for strength and quality. Casing spacers should be installed using double backed tape provided with the spacers in order to fasten them tightly to the carrier pipe. Casing spacers for fusible PVC carrier pipe shall be as manufactured by Raci North America, or approved equal.

1.06 SANITARY SERVICE LATERAL CONNECTIONS

- A. Tee-wyes shall be a minimum of four (4) inches and shall be the same diameter as the run of the pipe. They shall be of the same material as the sewer main. Tee-wyes shall be used for all service connections to new sewer main.
- B. Service Saddles: Service Saddles shall be flexible sewer saddles with double stainless steel straps or PVC Inserta TeesTM. Service Saddles shall only be allowed for new service connections to existing sewer mains.

1.07 SANITARY SERVICE LATERALS

- A. Laterals shall be either ductile iron with push-on joints, conforming to Paragraphs 1.01.C and 1.02.B.2, or SDR 26 Polyvinyl Chloride with bells and natural rubber rings for jointing, conforming to Paragraphs 1.01.A and 1.02.A.1.
- B. A saw cut "S" shall be cut in the top of the curb directly over the lateral location. Tracer wire shall be adhered to the lateral from the main and up to the cleanout.

1.08 METAL DETECTOR TAPE

Detector tape shall be installed over all nonmetallic gravity sewers. The tape will be equivalent to Terra-Tape by Griffolyn Co., Inc. of Houston, Texas. The tape shall be at least two (2) inches wide, green in color, and be labeled "Caution Buried Force Main Below" or "Caution Buried Sewer Line Below" on the tape in black letters. The tape shall

have a tensile strength of not less than 4,000 psi, dart impact strength of not less than 120 grams per 1.5 mils, be not less than 0.0055 inches thick, and include sufficient metal to allow easy detection from above ground. The detector tape shall be designed to last as long as the pipe it is installed over, even in adverse soils.

1.09 TRACER WIRE AND CONNECTORS

A. Tracer Wire

Tracer wire shall be installed on all force mains, with direct burial connectors, and provide continuous electrified conductivity. Area markers shall be at least every 500 feet with tracer wire attached, unless a manhole is available. A six (6) foot lead attached to the inside of the ring and cover shall be provided at manholes. On laterals, the tracer wire shall connect the clean-out to the gravity sewer.

1. Tracer wire shall be copper clad steel with high-density, high molecular weight polyethylene (HDPE) insulation, and rated for direct burial use at 30 volts. Conductor must meet 21% conductivity for locate ability purposes. HDPE insulation shall be RoHS compliant and utilize virgin grade material. Insulation color shall meet the APWA color code standard for identification of buried utilities.
2. Tracer wire for direct burial shall be a #12 AWG HS-CCS high-strength copper clad steel conductor (HS-CCS), insulated with a 30 mil, HDPE insulation. Minimum break load shall be 380 lbs. Wire must be installed in the 3 o'clock position during installation. Tracer wire shall be Boar Tough High Strength CCS PE30 UL by Agave Wire Ltd or Copperhead HS-CCS HDPE 30 MIL or Pre-Approved Equal.
3. Tracer wire for directional drilling/boring shall be #12 AWG extra-high-strength copper clad steel conductor (EHS-CCS), insulated with a 45 mil, HDPE insulation. Minimum break load shall be 1,150 lbs. Tracer wire shall be Boar Tough Extra High Strength by Agave Wire Ltd, Copperhead EHS-CCS HDPE 45 MIL or Pre-Approved Equal.

B. Connectors

1. Wire connectors shall be UL 486D listed, one-piece direct bury twist-on type, UL designation MDB, sealed wire connectors. Max voltage shall be 600 Volts. Connectors shall be rated to 105° C and sized to accommodate a minimum of four (4) #12 copper / steel core tracer wires. Silicone sealant shall be rated for

temperatures from -45° F to 400° F. Connector shall be DryConn King 6 Blue by King Innovation, or pre-approved equal.

2. Spliced connectors shall be direct bury design, with a maximum voltage of 50-volts. Spliced connectors shall have a tin plated high conductivity aluminum lug, zinc-plated steel screws, high-impact polypropylene housing, and a non-hardening viscous dielectric silicone sealant. Silicone sealant shall be rated for temperatures from -45° F to 400° F. Spliced connector shall be DryConn Direct Bury Lug Aqua, or pre-approved equal.

- C. Area Markers – Utility marker posts equal to Rhino TriView Plus Test Station shall be installed every 500-foot along force main mains. Posts shall be marked as “Sanitary Sewer Force Main”.

1.10 FORCE MAIN SUBSURFACE MARKERS

Omni-balls or equal shall be installed above force main pipe at all bends, and at least every 500-foot along straight pipe runs.

1.11 POLYETHYLENE ENCASEMENT

Polyethylene encasement shall be used on all ductile iron piping, and shall be in tube form conforming to the requirements of ANSI/AWWA C105/A21.5 latest revision. The polyethylene film shall have the following characteristics:

Tensile Strength:	1,200 psi minimum
Elongation:	300 percent minimum
Dielectric Strength:	300V/mil thickness minimum
Thickness:	Nominal thickness of .008 inch (8 mil)

1.12 BEDDING AND BACKFILL

- A. Classification of Materials – ASTM D-2321 classifies soils using the Unified Soils Classification System (ASTM D-2487). For the purpose of this specification, soils to be used as backfill material are grouped into five classes according to soil properties and characteristics.

1. Class I - Angular, 1/4 to 1-1/2 inch graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, crushed gravel, and crushed shells.

2. Class II - Coarse sands and gravels with maximum practical size of 1-1/2 inch, including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class.
 3. Class III - Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Soil Types GM, GC, SM, and SC are included in this class. These materials are not to be used for bedding or haunching.
 4. Class IV - Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH, and CL are included in this class. These materials are not to be used for bedding, haunching, or initial backfill.
 5. Class V - This class includes the organic soil, OL, OH, PT as well as soils containing frozen earth, debris, rocks, larger than 1-1/2 inch in diameter, and other foreign materials. These materials are not to be used.
- B. Stone Bedding - Stone used for foundation, bedding, and haunching shall be shall be crushed stone or gravel conforming to ASTM C33, size #57, with size range of ¾ to 1-inch, free from debris, roots, trash, stones, or other harmful substances.
- C. Backfill – Whether imported borrow material or from on-site excavations, backfill shall be suitable Class II or Class III material. Backfill material shall be free from debris, roots, trash, stones, or other harmful substances. Suitable soils are those complying with ASTM-2487 soil classification groups GW, GP, GM, SW, SP, and SM.

1. Common Backfill

Common backfill shall consist of mineral soil, substantially free of clay, organic material, loam, wood, trash, and other objectionable material which may be compressible or which cannot be compacted properly. Common backfill shall not contain stones larger than 6 inches in any dimension, asphalt, broken concrete, masonry, rubble, or other similar materials.

The backfill shall have physical properties such that it can be readily spread and compacted during filling. Additionally, common backfill shall be no more than 12 percent by weight finer than the No. 200 mesh sieve unless finer material is approved for use in a specific location by the City.

Material falling within the above specifications, encountered during the excavation,

may be stored in segregated stockpiles for reuse. All material which, in the opinion of the Engineer, is not suitable for reuse on the site shall be removed and disposed of by the Contractor.

2. Select Backfill

Select backfill fill shall be as specified above for common backfill, except that the material shall contain no stones larger than 1-1/2 inches in largest dimension, and shall be no more than 5 percent by weight finer than the No. 200 mesh sieve.

3. Borrow Material

Where it is determined that sufficient suitable material is not available from the site to satisfactorily backfill the pipe to at least two (2) feet above the top of the pipe, suitable borrow material meeting the requirements of this specification unless otherwise noted, shall be provided by the Contractor from other sources at Contractor's expense. All material from the excavation unsuitable for bedding, backfill, or other uses as directed by the Engineer and approved by the Owner, shall be removed and disposed of by the Contractor.

1.13 PRODUCT REVIEW

The Contractor shall provide the Engineer with a complete description of all products before ordering. The Engineer shall review and approve all products before they are ordered.

PART 2 – EXECUTION

2.01 USE OF STANDARD CONSTRUCTION TECHNIQUES

- A. Responsibility for Proper Construction - The standard construction techniques presented herein for bedding, backfill, and compaction are suitable in areas of favorable soils. However, the ENGINEER SHALL REMAIN RESPONSIBLE FOR CONDUCTING ON-SITE SOILS INVESTIGATIONS appropriate for the nature of the project at hand. The ENGINEER SHALL REMAIN FURTHER RESPONSIBLE for providing the procedures and details necessary for proper gravity sewer or forcemain installation throughout the entire project corridor.
- B. Minimum Site Soils Investigation Requirements - All projects requiring the installation of any water or sanitary pipe other than service laterals shall require a minimum of one (1)

soil boring every 300 linear feet along the proposed utility corridor. Borings shall be to a depth of two (2) feet deeper than the deepest proposed line within 150 feet. A Geotechnical Report, identifying the type(s) of soils found on the project site shall be provided with the construction plan submittal. The report shall include, at a minimum, boring logs, (types of soils encountered, e.g. - type GW, GP, SW, SP, etc., depths of soil types, observed groundwater, seasonal high groundwater, etc.), and any special requirements for pipe bedding, backfill, or compaction. The location of the boring(s) shall be clearly shown on the construction plans.

- C. Use of Standard Procedures and Details - If site-specific procedures or details for bedding, backfill, compaction, and joint restraint are not provided in the contract documents and the Engineer includes only the standard City of Savannah specifications and details for pipe bedding and joint restraints, the ENGINEER IS ATTESTING THAT SOIL CONDITIONS ARE FAVORABLE, and that the STANDARD METHODS ARE ACCEPTABLE based on the soil conditions observed and the Engineer's experience.

2.02 CONSTRUCTION OBSERVATION

The line, grade, deflection and infiltration of sewers shall be tested by the Contractor under the direction of the Engineer. The Engineer will have the right to require that any portion of the work be done in his presence and if the work is covered up after such instruction, it shall be exposed by the Contractor for observation. However, if the Contractor notifies the Engineer that such work is scheduled and the Engineer fails to appear within 48 hours, the Contractor may proceed without him. All work done and materials furnished shall be subject to review by the Engineer or project representative. Improper work shall be reconstructed. All materials which do not conform to the requirements of the specifications shall be removed from the work upon notice being received from the Engineer for the rejection of such materials. The Engineer shall have the right to mark rejected materials so as to distinguish them as such. The Contractor shall give the Project Engineer or Project Representative a minimum of 48 hours notice for all required observations or tests.

2.03 LOCATION AND GRADE

The line and grade of the sewers and the position of all manholes and other structures are shown on the drawings. The grade line as given on the profile or mentioned in these specifications means the invert or bottom of the inside of the pipe. The price for trenching shall include the trench for the depth below this line necessary to lay the sewer to this grade, but measurements for payment will be made only to the grade line.

Master control lines and bench marks have been provided by the Engineer. The Contractor shall be responsible for the proper locations and grade of the sewers.

2.04 EXCAVATION

The Contractor shall perform all excavations of every description and of whatever substance encountered to the depth shown on the plans or specified for all sewers, manholes and other appurtenances. All trenches shall be properly dewatered before laying pipe, by the use of well points, pumping or other methods accepted by the Engineer.

The top portion of trenches may be excavated with sloping or vertical sides, except that the width of trench to a height of two (2) feet above the top of the pipe (embedment zone) shall not exceed two (2) feet greater than the diameter of the pipe.

Stone bedding beneath the pipe shall be required for all sewers and forcemains. Graded #57 stone shall be placed a minimum of six (6) inches deep and two (2) feet wider than the pipe at the barrel. Stone bedding shall be "compacted" using mechanical equipment to orient the stone and adjust trench bottom to grade. Compaction will be visually determined based on non-movement of material under compaction equipment.

Where the character of the soil is such that the Engineer determines it unsuitable to support the pipe bedding layer, an additional foot of excavation will be authorized and the trench backfilled with an additional foot of stone to create a foundation for the pipe bedding material. If the trench bottom remains unsuitable, the Contractor shall provide additional foundation material or install a non-woven filter fabric, (Mirafi 140N or equivalent), beneath the stone layer, as directed by the Engineer. Excavation in excess of the depths and widths required for sewers, manholes and other structures shall be corrected by backfilling with stone to the proper grade.

The limit of excavation shall be such to allow for placing and removing forms, installing sheeting, shoring, bracing, etc. The Contractor shall pile excavated material in a manner that will not endanger the work and will avoid obstructing sidewalks, driveways, power poles, etc. Excavated areas shall be kept free of water during construction and proper site drainage shall be maintained.

See City of Savannah Standard Construction Detail S-16 for additional information on trench excavation and bedding.

2.05 BRACING AND SHEETING

The sides of all trenches shall be securely held by trench boxes, stay bracing, or by skeleton or solid sheeting and bracing, as required by the soil conditions encountered, to protect the adjoining property and for safety in accordance with OSHA requirements. Where shown on the drawings or where directed by the Engineer, the Contractor must install solid sheeting to protect adjacent property and utilities. The sheeting shall be steel or timber and the Contractor shall submit design data, including the section modules of the members and the arrangement for bracing at various depths, to the Engineer for review before installing the sheeting. Sheeting shall be removed in units when the backfilling has reached the elevation necessary to protect the pipe, adjoining property and utilities.

When sheeting or shoring above the elevation cannot be safely removed, it shall be left in place. Timber left in place shall be cut off at least two (2) feet below the surface.

2.06 LAYING PIPE

A. Gravity Sewer Installation:

Depth of Pipe – The Contractor shall perform excavation of whatever substances are encountered to a depth sufficient to provide a four (4) foot minimum cover over the top of the pipe to the proposed grade. Maximum depth shall be 20-feet. If the cover will be less than the minimum, ductile iron pipe shall be used.

Placement - All gravity sewer pipes shall be laid upgrade with spigots pointing downgrade. The pipe shall be laid in a trench prepared in accordance with Paragraph 2.04 "Excavation," so that after the sewer is complete, the interior surface shall conform on the bottom accurately to the grades and alignment fixed or given by the Engineer. All pipes shall be cleaned out and left clean. Every third joint shall be filled around immediately after being properly placed. The recommendations of the manufacturer of the particular pipe joint used shall be adhered to.

Grade - The sewer lines shall be straight and show a uniform grade between manholes. Any sags or bellies in the pipe sections shall not extend longer than ten (10) feet or hold water more than one-eighth of the pipe's inside diameter.

B. Forcemain Installation

Depth of Pipe – The Contractor shall perform excavation of whatever substances are

encountered to a depth that will provide a minimum cover over the top of the pipe. Pipe 12-inches in diameter and smaller shall have 36-inches of cover from the proposed finished grade. Pipe larger than 12-inches in diameter shall have 48-inches of cover from the finished grade. A maximum cover of 60-inches from finished grade shall be used unless approved by the City to avoid a conflict. If the depth of cover will be less than the minimum, ductile pipe shall be used.

Placement - Forcemain shall be laid in a ditch prepared in accordance with Paragraph 2.04 "Excavation", so that after the forcemain is complete, the interior surface shall conform on the bottom accurately to the grades and alignment fixed or given by the Engineer. Holes shall be provided to relieve bells from bedding strain, but not so large as to allow separation of the bell from the barrel by settlement after backfilling. All pipe shall be cleaned out and left clean. Every third joint shall be filled around immediately after being properly placed. The installer shall adhere to the recommendations of the manufacturer of the particular pipe joint used.

2.07 METAL DETECTOR TAPE

As a part of the installation of gravity or force main sewer, the Contractor shall place metallic detector tape, suitably coded, over the installed pipes at a depth not to exceed eighteen (18) inches below the finished surface.

2.08 TRACER WIRE

All force mains and sanitary sewer laterals below grade shall have tracer wire installed directly on the pipe in the 3 o'clock position. The wire shall be secured to the pipe with tape or other accepted methods at a spacing of no more than 36-inches apart. Where appurtenances connect to the force main, the specified spliced connector shall be used. The insulated wire must maintain electrical conductivity. In addition, tracer wire shall locate laterals by connecting cleanouts to gravity sewers. This tracer wire system shall be checked and tested by the Contractor, in the presence of the Engineer or project representative, prior to acceptance of the force main installation. All equipment, meters, detectors, etc. needed for testing shall be furnished by the Contractor.

2.09 SEPARATION BETWEEN WATER & SEWERS

Water mains and/or laterals shall not be laid closer than ten (10) feet horizontally to a sanitary or storm sewer without written instruction from the Engineer. Some deviation may be allowed on a case by case basis if approved by the City for installation of the

water main closer to a sewer, provided that the water main is laid in a separate trench, such that the bottom of the water main is at least eighteen (18) inches above the top of the sewer. In no case, shall the water and sewer lines be closer than five (5) feet horizontally edge to edge. Water mains crossing sewers should be laid to provide a minimum vertical distance of eighteen (18) inches between the invert of the water main and the top of the sewer line. The water and sewer lines must be ductile iron when laid in violation of the separation requirements. One full length of water pipe shall be located so both joints will be as far from the sewer as possible.

2.10 CONNECTIONS TO EXISTING SEWER MAINS

Connections to existing sewer mains may be performed with the use of two different connections devices:

- A. A saddle matching the existing main line pipe diameter with either four (4) or six (6) inches lateral connections may be used. The existing lines must be cut with a round cutter so that the opening will allow the hub of the saddle to fit inside the opening. Square holes cut with a pipe saw will not be acceptable. The saddles must be gasketed. Stainless steel straps must be used to attach the saddle to the existing sewer main. The sewer main must be protected from existing debris around the pipe from entering the line during the attachment of the saddle. The area around the existing sewer pipe must be compacted to 100% density. All saddles must be attached to the sewer main at either the 2:00 or 10:00 position. No laterals will be attached to the sewer main at the 12:00 position.
- B. The other alternative to attaching sewer laterals to an existing main is by using an Inserta Tee. This device can be connected to the main by drilling an appropriate size round hole for the four (4) or six (6) inch lateral. The proper Inserta Tee for the existing sewer line pipe material must then be installed by inserting the rubber boot inside the sewer main. A PVC insert, lubricated properly, is then inserted inside the boot, then a stainless steel strap ties the boot to the insert. The insert then accepts PVC pipe of the appropriate size. The site must then be 100% compacted around the lateral. All connections to existing sewer mains must be inspected by the City prior to backfilling.
- C. Depth of Pipe – Sanitary service laterals shall have a minimum depth of cover of three (3) feet under paved or other traffic areas or two (2) feet under non-traffic areas. If the minimum cover is not available, a ductile service lateral shall be required. Sanitary laterals shall have a minimum slope of 1% towards the collection system.

2.11 BACKFILLING

See City of Savannah Standard Construction Detail S-16 for additional backfilling information.

- A. All trenches and excavation shall be backfilled immediately after the pipes are laid therein, unless other protection of the pipe line is directed. Backfill shall be spread in successive layers of loose material. Each layer shall be spread uniformly and tamped until thoroughly compacted.
- B. Haunching - Haunching for gravity sewer and forcemain pipe shall be #57 stone and installed from invert to springline by hand placement to ensure material is worked under the haunch of the pipe and so as to provide full bearing around the bottom of the pipe. Haunching shall be carried up evenly on both sides to prevent injurious side pressure.
- C. Initial Backfill – Initial backfill is placed from the springline of the pipe to two (2) feet above the pipe. It is the final layer of backfill in the embedment zone. Initial backfill for gravity sewer lines shall be performed using Class II or better select backfill and for forcemains initial backfill shall be performed using Class III or better select backfill. Backfilling of the trench shall be carried on simultaneously on both sides of the pipe in such a manner that injurious side pressure does not occur. Trench backfill in the embedment zone shall be compacted in six (6) inch lifts.
- D. Final Backfill – Final backfill is placed from above the embedment zone (two-feet above top of pipe) to final grade. Final backfill shall be performed using Class III or better common backfill material. Backfill may be selected from excavated material anywhere on the work if any of the material is suitable. Backfill may be by hand or mechanical placement. Trench backfill above the embedment zone shall be compacted in twelve (12) inch lifts.
- E. Compaction - Under the traffic areas the top 12-inches of backfill material shall be compacted to a density of not less than 100% at optimum moisture. Below the 12-inch line and to and including the area around the pipe the density shall not be less than 95% at optimum moisture. In areas other than traffic areas, the backfill material shall be compacted to 95% density at optimum moisture. Compaction tests shall be conducted in accordance with ASTM D-1556 or D-2922 by an independent testing laboratory. The tests are to be taken at the direction of the Engineer to average not more than 100-foot intervals. Laboratory Tests shall conform to ASTM D-698.

- F. Whenever the trenches have not been properly filled, or if settlement occurs, they shall be refilled, smoothed off and finally made to conform to the surface elevation of the ground. Backfilling shall be carefully performed and the original surface restored to the full satisfaction of the Engineer immediately after the installation. The finished surface shall be free of depressions and shall not allow ponding of stormwater runoff above utility lines.
- G. Where thermoplastic (PVC) pipe is installed, the Contractor shall take precautions in accordance with ASTM D-2321, during the backfill operations so as not to create excessive side pressures, or vertical or horizontal deflection of the pipe so as not to impair flow capacity.

2.12 JACKING AND BORING

Steel casing of the diameter shown on the plans shall be jacked and bored in the locations indicated. Joints between sections of the steel casing shall be welded by a certified welder. Boring and jacking shall be in accordance with the provisions of Section 65 of the Georgia Department of Transportation Standard Specifications. After the carrier pipe has been installed, the ends of the casing shall be sealed with Class "C" concrete after observation by the Engineer.

Where the work involves a State highway, the Resident Engineer of the State Department of Transportation shall be notified by the Contractor three (3) working days before the crossing is started. Where the work involves a railroad, the work shall conform to the requirements of American Railway Engineering Association specifications and the Division Superintendent of the Railroad shall be notified three (3) working days prior to beginning the work. Before commencing work within the rights-of-way of the railroads or highways, the Contractor shall verify that the Owner has obtained the required permits.

2.13 MANHOLES

- A. Manholes shall be constructed on compacted bedding material so structure is plumb and pipe inverts are at the proper elevation where shown on the drawings or where directed by the Engineer. Manholes shall be installed at the end of each line, at all changes in grade, size, or alignment, at all intersections, and at distances not greater than 400-feet. The channel in the bottom of the manholes shall be smooth and properly rounded and the invert channel shall be same size as installed sewer line. Special care must be exercised in laying the channel and adjacent pipes to grade. Invert piping shall

not extend inside manhole any further than two (2) inches. The tops of manholes outside of roads shall be three (3) inches above the finished ground surface unless otherwise shown on the plans. Manholes in roads shall be built to grades designated by the Engineer. Manhole sections with either honeycomb defects; exposed reinforcing; broken/fractured bell or spigot or cracked walls will be subject to rejection by the Engineers for use on the project. When mastic sealant is used, improperly applied primer will also be cause for rejection.

- B. No leaks in any manhole will be acceptable. All repairs made from inside the manhole shall be made with non-shrink grout.
- C. A one-tenth (0.1) foot minimum drop shall be required through all manholes where the horizontal alignment change is less than 45°. A two-tenths (0.2) foot minimum drop shall be required through all manholes where the horizontal alignment change is 45° to 90°. Horizontal alignment changes greater than 90° at a single manhole shall not be allowed. A wide sweep invert shall be required for all manholes where the horizontal alignment change is 90°.

2.14 PROTECTION OF EXISTING SANITARY SEWER SYSTEMS

During the construction of new Sanitary Sewer Systems, the existing sanitary sewer shall be protected at the point of connection with use of a pneumatic or mechanical plug. This isolation shall remain in place until the new system is fully accepted. Provisions must be in place to prevent sediment and excess water from entering the City's existing Sanitary Sewer System.

The isolation of the new system must be performed at the Contractor's expense. Any breach of this isolation shall be resolved by the Contractor to meet City expectations and standards. The Contractor may also be liable and responsible for remediation costs due to this breach.

2.15 CLEANING

Prior to mandrel tests, televising, and before acceptance of the gravity sewer systems, all sewer lines shall be cleaned to the satisfaction of the Engineer. Where any obstruction occurs, the contractor will be required to clean the sewers by flushing and by means of rod and swabs or other instruments. Cleaning of new sewers is to be completed without impacting the existing sewer system; debris/foreign material from the new line (i.e. dirt, sand, and trash) shall not be discharged into the existing system.

2.16 TESTING AND INSPECTION

A. Leakage Testing: Mains and Laterals

All new public and private gravity sewers and laterals shall be pressure tested within 30 days following final backfill in accordance with the Time-Pressure Drop Method specified in ASTM F1417 - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air, latest revision. The procedure is summarized as follows:

1. Isolate the section of the sewer line to be tested using inflatable plugs or stoppers.
2. Cap all laterals and stubs using glued caps. All caps and plugs shall be securely braced to prevent blow-out.
3. One of the plugs or caps shall have an inlet tap or other provision for connecting a hose to a portable air control source.
4. Connect the air hose to the inlet tap and portable air control source. The air source equipment shall include necessary valves and pressure gages to pressurize an oil-free air source at a controlled rate into the test section.
5. Add air slowly to the test section until the pressure inside the pipe reaches four (4) psi greater than the average backpressure of any groundwater submerging the pipe. (NOTE: All test pressures are measured as gage pressure, which is any pressure greater than atmospheric pressure. Since water produces a pressure of 0.43 psi per foot of depth, air test pressures must be increased to offset the depth of groundwater over the sewer line. If the groundwater is two (2) feet or more above the top of the pipe at the upstream end, or if the required test pressure exceeds nine (9) psi, this test should not be used).
6. Disconnect the air supply and allow a minimum of two (2) minutes for pressure stabilization.
7. Measure the pressure drop over the following time period, depending on the diameter of the sewer pipe being tested (based on a maximum test section length of 400 feet between manholes):

8 inch:	6 minutes
10 inch:	8 minutes

12 inch:	12 minutes
15 inch:	18 minutes
18 inch:	26 minutes

8. Acceptable pressure drop over time period: Not more than 0.5 psi.

The testing shall be performed by the Contractor, and a representative of the City shall be present to observe the test. The Contractor shall be responsible for all costs associated with performing the leakage testing, locating leaks, repairing leaks, and conducting additional leakage testing as necessary until the system passes the pressure test. No gravity sewers or laterals will be accepted by the City without a passing pressure test.

B. Deflection of Mains

It is the responsibility of the Contractor to assure that backfill is sufficient to limit deflection for all PVC pipe, eight (8) inch diameter and larger, to no more than 5% of the internal diameter of the pipe which shall be tested by a mandrel permitting no greater than maximum 5% deflection. All pipe shall be tested no sooner than 30 days after installation. All pipes not passing the 5% deflection limitation test shall be repaired or removed and replaced.

The mandrel shall be pulled through the pipe (SDR-26) with the following diameter:

<u>Nominal Pipe Size (Inches)</u>	<u>Average inside Diameter (Inches)</u>	<u>Mandrel Diameter (Inches)</u>
8	7.754	7.37
10	9.692	9.20
12	11.538	10.96

C. Deflection of Laterals

It is the responsibility of the Contractor to assure that installation and backfill is sufficient to limit obstructions and deflections in the laterals. Laterals shall be tested by dropping a tennis ball in the upstream end of the pipe. The tennis ball must show up at the next downstream manhole. If not, the lateral must be repaired or removed and replaced. The tennis ball may be followed by water to help with its travel to the next downstream manhole.

D. Televising

After the completion of successful mandrel tests and cleaning, all newly constructed sewer lines must be televised by the City prior to acceptance. Accordingly, all sewer lines, eight (8) inches in diameter and larger, that are installed within accepted public right-of-ways and easements will be televised, including those lines on private property that are connected to the public lines. Contractors will be charged a fee per linear foot by the City, and will be responsible for preparing the lines to insure that they are cleaned and free of debris prior to televising. Contractor shall notify the Inspector on his progress prior to the televising request. Details and procedures of this program are included in the "Televising Procedures Manual" developed by the City's Water Quality Control Department who will be providing the television services. Contractors will be responsible for becoming familiar with this manual. This Manual is available on the City's Website.

E. Compaction

Laboratory tests of the soil shall be made in accordance with ASTM D-698. In-place density tests shall be made in accordance with ASTM D-1556 or D-2922. Results of the tests shall be furnished to the Engineer by the testing laboratory. The minimum number of tests required shall be:

1. Backfill over sewer in traffic areas: 1 per 100 linear feet or less for each four (4) feet of depth or portion thereof.
2. Backfill over sewer in non-traffic areas: 1 per 200 linear feet or less for each six (6) feet of depth or portion thereof.

2.17 CLOSING PIPE

When the work or pipe laying is suspended, either for night or at other times, the end of the gravity sewer or force main pipe must be closed with a water tight cover. The Contractor will be held responsible for keeping the gravity sewer or force main free from obstruction. Plugs shall remain in pipe ends until all water is removed from the trench.

2.18 GRASSING

Grassing of areas disturbed during construction shall be in accordance with Section 02485 – "Grassing".

2.19 ACCEPTANCE OF PORTIONS OF THE WORK

The Owner reserves the right to accept and use any portion of the work whenever it is considered to be in the City's interest to do so. The Engineer shall have power to direct on which line the Contractor shall work and the order of the work.

2.20 RECORD DATA

As required under Section 1500, Paragraph 54, of the General Conditions, the Contractor is required during construction to keep accurate, legible records of the location of all new sewers, force mains, tees and laterals. This record data will include survey coordinates of all bends and fittings on the force main. These records will be made available to the Engineer before his final review for incorporation into the consulting Engineer's Record Drawings. Final payment to the Contractor will be withheld until all such information is received and accepted.

END OF SECTION 02554